A Modified Quality Control Method for Manufacturing Process in Mask Industry

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Keywords: Manufacturing Process, Mask industry, quality control, and Six Sigma technique

Abstract: Masks are widely used in different industries, for example, traditional metal industry, hospitals or semiconductor industry. Quality is a critical issue in mask industry as it is related to public health and safety. Traditional quality practices for manufacturing process have some limitations in implementing them in mask industries. This paper aims to investigate the suitability of Six Sigma quality control method for the manufacturing process in the mask industry to provide high quality products, enhancing the process capacity, reducing the defects and the returned goods arising in a selected mask manufacturing company. This paper suggests that modifications necessary in Six Sigma method for effective implementation in mask industry.

Introduction and Background

In general, the Six Sigma technique is a part of TQM and is used to improve the performance for the manufacturing process. Sigma (σ) presents the variability level of products and the process of observation. It can also measure the level of product's quality in which the higher level will produce the lower defect goods. At Six Sigma level, maximum number of effects is 3.4 per million opportunities [1] . The Six Sigma technique is a philosophy and a methodology for analysing data with statistical tools to improve quality and eventually finding root causes of quality problems and implementing controls. Therefore, the Six Sigma technique was originally developed for manufacturing organisation [2] . It is inspired by Deming's "Plan – Do- Check – Act (PDCA)" and the basic concept of the Six Sigma technique is consisted by five phrases which are DMAIC (Define – Measure – Analyse – Improve – Control) [3] .

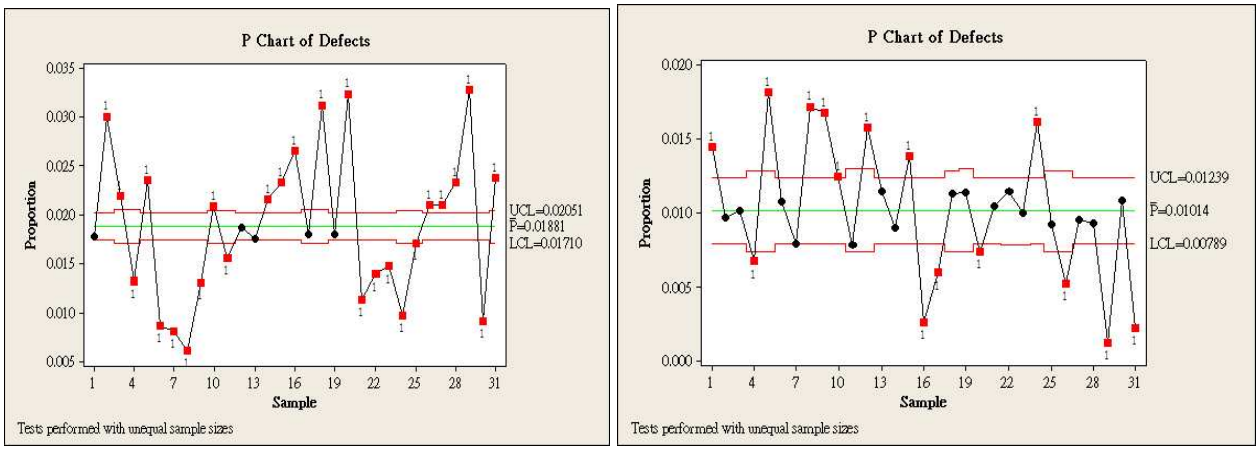
Mask industry became an important industry in the recent time because of the outbreak of some serious diseases such as the Severe Acute Respiratory Syndrome (SARS), bird flu, influenza, swine flu and hay fever. As the masks are used to prevent dangerous diseases and safeguard people, its quality is very important. Manufacturing high quality mask is premier aim for the mask industry [4] . The overarching goal of the research project is to investigate the quality control practices in the mask industry and suggest modifications in the practices necessary for this specific industry.

Currently, the traditional quality control (QC) technique is used in manufacturing masks including total inspection for entire manufacturing process and random inspection for incoming raw materials. In this case company, the manufacturing department has two types of manufacturing machines. One is the automation machine in which raw material is fed into the machine and the machine provides the finished goods. Another type machine is the two steps machine. In these machines, raw material is fed into one machine and the machine provides semi-finished products. Then the operators need to put the semi-finished goods into another machine to produce final products.

Result and Discussion

Data Collection and Analysis

Production data for July and October 2009 was obtained from the case organization. Results are presented in the following figures in the P chart. The P charts shows proportion of defective goods.



(a) (b)

Figure 1 (a) is the result of semi-finished goods in October of 2009 and (b) is the result of finished goods in July of 2009 by utilizing the Minitab software.

After analysing the historical data by utilizing the Minitab [5] , it is obvious that a large amount of masks are defective and falls outside the control limits. Some of those defective masks could be repaired and sold to other customers but some of them will become just scrap.

It can be seen from both of the diagrams that there have been many defective goods for semi-finished and finished products. The manufacturer has produced approximately 45,007 pieces and 5,081pieces semi-finished and finished products respectively. It was found that the semi-finished goods are one of the main causes of quality problems in the finished products. Currently, the case company is using traditional quality control technique and performs total inspection and random inspection for quality control. The workers who are working in the workplace visually inspect the product's quality. The visual inspection has an inaccuracy problem.

Determination of root causes of quality problems

This research will utilize the DMAIC method of the Six Sigma technique into the manufacturing of mask industry. The United Excel Enterprise (UEE) Company will be studied as a case organization for this study. The reason for choosing the DMAIC model is that the DMAIC model focuses on the existing process for improving the quality. The first step of Six Sigma technique is to define and discover the critical problems. When a company identify problems or root causes, the project team leader should analyse the data and consider the possible solutions. The company could utilize the statistical tool or software which could help the company understand the root causes. Moreover, the team should evaluate and implement the projects after the team leader decided the goals or projects. The team leader should also ensure the continuing to improve the project. In the Six Sigma technique, the control step is a critical element for a long term quality improvement [6] .

As a part of the research, selected employees from the mask company were interviewed regarding the quality problems. Analysing the data from the interviews, it was discovered that there are many causes which led to a large quantity of defective goods, for instance, the raw material problems from suppliers, the human factors from the employees and the working station environmental issues. According to the interviewers' opinions and brainstorming, there are four main causes which could cause the defective goods. There are shown in the following figure using a cause and effect diagram.

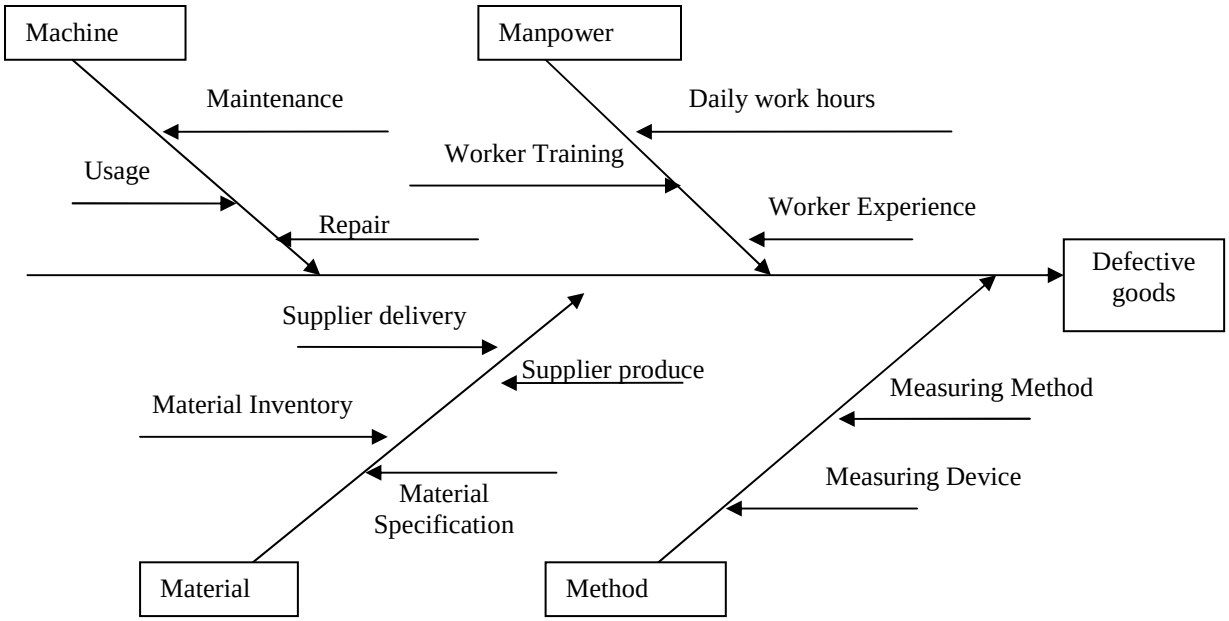


Figure 2 The Causes and effect diagram for providing the defective products.

Pareto principle means that the eighty percent of defects may be the result of twenty percent of the causes [7] . There are some possible causes of defective products including defective raw material, defective semifinished goods, machine problems, machine adjustment problem, inspection method and lack of employee training. The Pareto chart below shows that raw material, semifinished goods, machine problems, speed problem, no concentration and inspection method are the main causes of quality problems and the company should focus on these categories out of the many others for problem solving.

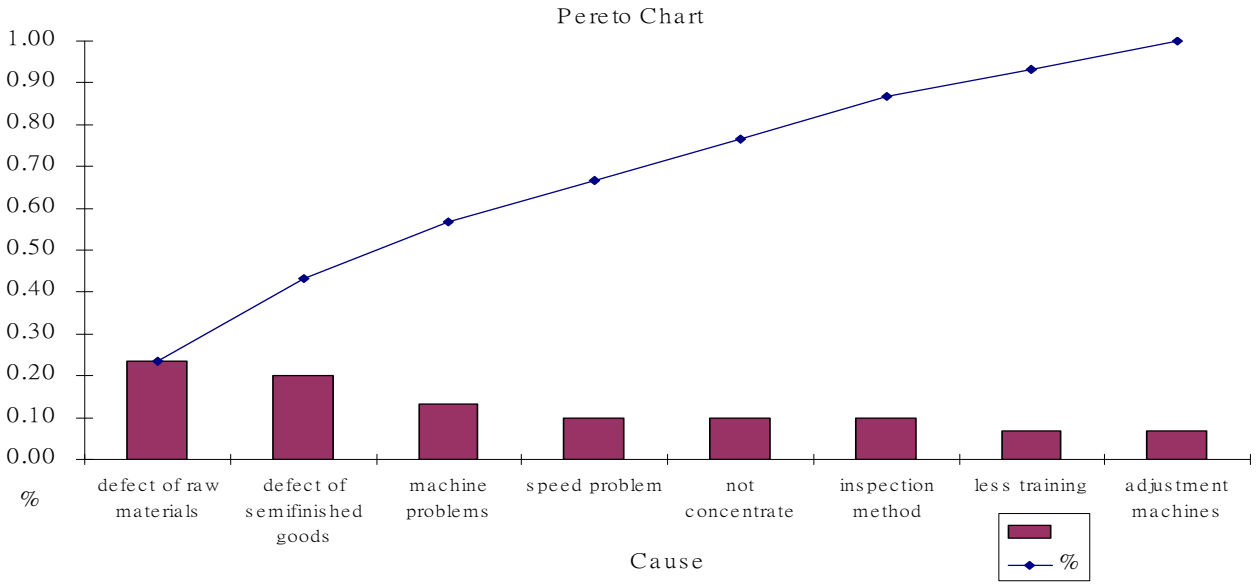


Figure 3 The Pareto chart is identifying the problems.

Analysis of production data, interview with the staff and personal observation suggests that there are some possible limitations in implementing the traditional quality control method. For instant, the workers lack of their experiences of inspection method. Employees quickly and visually check the appearance of product and size during the processing the products. Sometimes they cannot

discover the defective goods at this moment. Another possible limitation is that the inspection method itself is not accurate. Sometimes they slip checking some products while they are required to perform 100% inspection. Moreover, the suppliers are also a major source of quality problem. Sourcing suppliers with good quality record can minimize the quality problem at UEE Company.

Currently, the mask manufacturing corporation does not use the Six Sigma technique for controlling the quality. This research suggests that the Six Sigma technique can be first introduced and implemented into the mask industry. This research also suggests that usage of statistical software Minitab 15 will greatly enhance the data analysis capability of the quality control department. At present, the acceptation of quality level in the mask company is around ninety-five percentages which means the company only achieved around Five Sigma. The industries should strive to achieve Six Sigma. From the analysis of the interview data and close observation it is also suggested that UEE Company needs to focus on the research and development of high quality the new masks, and source high quality raw material. In those stages, the quality control and manufacturing departments are very important. The employees who are working in those departments require adequate training. This project will advance a greater understanding for quality control employees and operators of each working area. It will impact on those people and involve them in manufacturing and inspecting the high quality products.

Conclusions and Summary

In this research, it has been found that the Six Sigma technique is a suitable tool for improving the quality in mask industry. This project utilized the "DMAIC" model for enhancing the product's quality. The root causes of providing the defective goods in the UEE Company are from the raw material and inspection method. There are some possible resolutions for these quality control issues in this company. Along with implementing six sigma method of quality improvement, the company should build good relationship with suppliers, train their employees and conduct R & D for continuous development of high quality masks. The company should request the supplier to provide the quality reports for each batch of raw material.

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